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ABSTRACT

Learning activities that are associated with programed materials can be applied to learning from ordinary text; in fact, there is no essential difference between programed and ordinary text. Active response so important to programed learning can be controlled in textual materials by carefully defined adjunct aids such as word lists, underlining, and the types of questions asked. Sequencing of information, which is related to the organizational characteristics of a text, significantly influences recall. Appropriate pacing is more difficult with ordinary reading materials because the material is not divided into small, easily assimilated chunks as is the case of programed instruction. It has been suggested that the reading process should be slowed down, and this could be accomplished by inserting cues that would elicit appropriate learning activities. Adjunct aids in the form of typographical cues, questions, advance organizing statements, charts, etc. can direct attention and guide learning by the cue properties that are in the text. These aids may function to arouse, direct, simplify, prompt, pace, sequence, maintain, amplify, and train learning activities. Seldom is the kind of task analysis done, however, that would make it possible to adequately build adjunct aids. References are included. (DH)

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# A Heuristic Model for Research on Prose Learning[1]

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## INTRODUCTION

In the following discussion I would like to elaborate on the notions of "active responding" and "instructional control". These concepts, which have grown with contemporary instructional technology, are intimately involved in learning from a wide variety of printed materials. In particular, I would like to discuss some parallels between learning from ordinary text and learning from what often goes by the name of programmed materials.

I propose that, from the standpoint of learning activities, there is no essential difference between programmed and ordinary text, inasmuch as both perform similar functions, with varying degrees of success, toward the achievement of specific knowledge outcomes.

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[1]In F. Farley (Chm.) Prose learning: new directions. Annual Meeting of the American Educational Research Association, New York, February, 1971.

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In the following pages I will briefly review some studies that implicate sequencing, step-size, prompting, and pacing in textual learning. My aim, aside from pointing out how these and other factors might be involved in reading activities, is to arrive at some suggestions concerning the functions that adjunct aids (such as verbal directions or questions) might perform in controlling them. As a consequence of these considerations, we might hope eventually to come to a clearer understanding of the kinds of implicit self-instructions that mediate effective reading activities.

ACTIVE RESPONSE AND INSTRUCTIONAL CONTROL

Let me consider, briefly, what an active response entails in conjunction with written materials. In a program frame, for instance, the learner is required to make a response in order to insure that he processes the information in that frame appropriately. What is appropriate, of course, is a matter of learning objectives. The blank, or problem set by the response requirement, has two functions; (1) to arouse problem solving activities and, (2) to define the cues in the text that should provide the occasion for the correct response. Our understanding of the cues in sentences that provide the occasion for the correct response is crucial if we are

to understand how a frame succeeds in producing learning. Since these sentence cues themselves must be responded to, they elicit covert components of the overt response requirement; it is their function to control verbal responses that mediate (see Anderson, 1969) learning. Active responding then, as Rothkopf (1963) has pointed out, in no way implies that all these responses must be overt. Indeed, the most significant responses are quite removed from whatever is designated as the response requirement in a frame, whether that particular response is itself overt or covert. My point is that our notion of instructional control hinges upon an understanding of the cues that control covert responses associated with ordinary language habits, and that these habits are common to learning from programmed and ordinary text materials.

Consider for instance, a study by Anderson and Faust (1967) in which an obvious text cue performed a directive function that was inappropriate for important learning objectives. Their learning materials consisted of frames in which the correct response was a Russian word. Several sentences in the text defined the English words in terms of their Russian equivalents, and below them was a problem sentence with a blank to be completed, e.g., "A table is a _____." Under one condition the word

"stohl" was underlined in the text; under another condition "stohl was not underlined. Anderson and Faust found that the no-underline version produced better retention of the word equivalents, although the no-underline and underline groups performed equally well in the program. Presumably, the underlined words could be copied directly from the text without searching through the English equivalents. This study indicates how the student response might be defined in terms of an analysis of the cues in sentences that elicit learning relevant activities. In this case, an underlining cue provided an inappropriate directive function.

Active or meaningful responding and instructional control then, can be thought of as intimately related concepts because in a frame (or when a question is asked about a text), the arousal and associative functions of the response requirement are closely related. Indeed, there seems to be little distinction between the two unless we explicitly consider the physiological processes involved in activation. The implication is that if a reader can be made to respond in certain ways to appropriate cues in a text, then conceptual learning can be brought under control.

Let me give a further example to clarify this issue concerning active responding to meaningful components

of verbal material. We (Frase, 1969a) had subjects check off, as rapidly as possible, all the words in a list of 16 words that belonged to a general category (such as foods) or to a specific category (such as vegetables). The subjects were not told that a free-recall test would follow the search task. All the words in the list were foods, but half of them were vegetables and the other half were fruits. When a subject checked off the general category of foods, he responded overtly to every word in the list, but the only categorical response that he made was to "food". Under the specific search for vegetables, he responded overtly to half of the words, but he made a finer subdivision of the words in the list--he rejected half and accepted the other half. The hypothesis was that finer discriminations (although fewer overt responses) would produce greater recall. The results were as predicted; recall after the specific search was 45% and it was 28% after the general search.

ORIENTATING STIMULI AND STEP-SIZE

In the preceding section, I tried to indicate how the relationship between some covering task in a program or with word lists and the cues in the verbal materials can control the nature and extent of active responding.

The notion of controlling active responses via some covering instructions (which I have called orienting directions elsewhere--Frase, 1970a), was further explored in studies (Frase, 1969d; Frase and Silbiger, 1970) in which subjects searched through text to find the name of a planet that had a specified set of characteristics. When the text required searching for related sentences about a planet, the subjects remembered more planet names than when the information about a particular planet was grouped neatly together in one paragraph. The differences in retention induced by this search activity held up over a period of one month. This study parallels the Anderson and Faust study (1967) cited earlier, except that a somewhat more complex cue in this study, the distribution of information in a text, elicited active responding.

Other studies (Frase, 1969b, 1970c) concerned search for inferences in a text. In these studies, subjects were given statements, such as "Planets in Galaxy IV support life." Their task was to evaluate the truth of such statements on the basis of the information in the text. This could be done by relating sentences, such as "All the planets in Galaxy IV are "Blue". All the "Blue" planets support life." In some cases, the problem state-

ment was a direct quote from the text and it did not require relating sentences. From our analysis of these texts, we predicted the flow of subjects active responding as it would be guided by the text cues (in the form of logical classes). The aim of these studies was to see whether the items that got into memory were components of the solutions to the problems.

Although the order of the text sentences was varied, subjects tended to remember the sentences related to the solution of the problems, but not other sentences. The questions were very efficient in inducing selective responding.

As the number of sentences required to answer a question increased, so did recall. But, it was clear that subjects did not remember the inferential statements that mediated problem solution. For instance, if they used three text sentences and successfully derived two inferences which could be put together to confirm the problem inference, they would remember the text sentences, but they would not remember the intermediate inferential sentences. In short, higher level knowledge seemed beyond the effective range of these problems. Here we have an example of how necessary it may be to carefully control and reinforce the separate mediating stages in text learning.

These findings occasioned some concern that the process of student mediated control might be an extremely tenuous one; that it might break down if long chains of responses were required without support beyond one simple problem statement or direction. This failure corresponds in some ways to failures of programmed materials in which the student is required to perform a task before mastery of its component elements; the problem of step-size.

We decided to try analogous questions with children in grades 2-6 in order to replicate some of our findings. In two studies (Frase and Washington, 1970; Maroon, Washington and Frase, 1971) children read short stories and they evaluated the truth of simple statements printed below them. The children evaluated statements that would involve relating two or three sentences, or only locating the information in one sentence. For instance, the texts included statements such as; "The red thing was a bag. The bag was full of money." To evaluate the statement "The red thing was a bag." requires only one of my example sentences, but to evaluate "The red thing was full of money." involves both of them. In these studies, the text was available to the children when they solved the problems; long-term recall was not at issue.

The results showed that questions requiring responses to more than one text sentence were significantly more difficult than those requiring responses to only one sentence. It was somewhat surprising to us that a chain of only two sentences could significantly depress performance, but the data recently published by Bormuth and others (1970) confirm that multiple-sentence problems are especially difficult to solve.

PROMPTING

From these studies it seemed clear that carefully defined prompts would be needed to control complex learning outcomes. Our thought was that part of the difficulty of handling relationships among sentences might be due to the fact that the class cues in the text, such as the words "red thing", might not be sufficiently salient to cue subjects' selective responses, i.e., the subjects were unable to appropriately segment the text so that related items could be compared. In an attempt to increase the salience of these verbal items so that they might activate higher level activities, Washington (unpublished) prompted children by warning them to pay special attention to the "red thing" or to the "green thing", etc. These prompts did not influence solutions to the simple one sentence problems, but they effectively reduced errors on the questions requiring responses to multiple sentences.

SEQUENCING

In previous studies with adults on drawing inferences from text (Frase, 1969b, 1970c), we had observed that the sequence of sentences in a text significantly influenced recall. Likewise, with children we found that if sentences were not well sequenced in terms of the conceptual linkages between them, problem solution was poor. For instance, the problems could be answered well with sentences in the order; "The red thing was a bag. The bag was full of money.", or the order, "The red thing was a bag. The green thing was a box." But if the order alternated both a concept and an attribute category, e.g., "The red thing was a bag. The small thing was empty.", then performance dropped. Studies with children and adults (Maroon, Washington and Frase, 1971; Frase, 1970c) showed that problems involving responses to chains of sentences suffered the most when the text was poorly sequenced.

The problem of sequencing information relates directly to the organizational characteristics of text. I have reported some of these correspondences elsewhere (Frase, 1969c). In text, the sequence of conceptual information resembles, on a molecular level, the problem of correctly ordering the mastery of knowledge and skills in terms of frames in a program.

PACING

The fact that students can proceed at their own rate is common to both text and programmed instruction. This may be an especially critical factor with ordinary reading materials however, because the material is not broken into small easily assimilated chunks, hence, the student who reads a text without varying his speed to correspond to a difficult passage will find that his comprehension of subsequent material is prejudiced. Tendency to vary reading rate should depend upon whether a reader is sensitive to the cues in a text that signal difficulties, such as syntactic and semantic transformations, relationships among sentences, or the need to recall some item of previously learned information.

Two studies were conducted to explore the interaction of text difficulty with reading rate (Frase, 1970 d). Subjects read a text which consisted of simple facts. Sentences bearing complex temporal or logical relationships were embedded in those facts. Before reading, the subjects were told that a test would follow. They were also told that there was different kinds of information in the text, and they were given brief training showing them how they might draw inferences and order temporal events. The aim was to insure that the

complex information would cue complex processing. In one study the text was presented under paced conditions at the rate of three lines every 10 seconds. Under these paced conditions, the subjects could recall little of the information that followed the complex relational sentences. Recall for the preceding content was not affected. In another study, subjects were allowed to read the same text in toto under unpaced conditions. Under these conditions, the complex sentences did not influence the recall of subsequent or preceding content.

FUNCTIONS OF ADJUNCT AIDS

In text, the cues that should signal difficulties, relationships, or important concepts, often are not acted upon. The tendency to continue reading, to complete a thought or a paragraph, even when undefined terms are encountered, is great. Indeed, Richards (1959) has maintained that learning from text might be improved substantially by slowing down the reading process. He has suggested a tentative set of symbols that could be inserted in text. Their function would be to elicit appropriate learning activities in the presences of selected words, phrases and sentences. These adjunct cues would vary the pace at which a reader progressed through the material and provide him with additional

supports in the form of prompts for particular activities. Such activities, I presume, might relate to syntactic, semantic or inferential behaviors, or the cues might provide cross referencing to related information in other portions of the text. To my knowledge, Richards' proposals have not been followed up in an empirically systematic way.

In view of proposals such as these, and the wide use of adjunct aids, it might be useful to consider what the studies reviewed in this paper have to suggest in the way of functions that adjunct aids could perform. Under adjunct aids I would include typographical cues, questions, advance organizing statements, diagrams, charts, etc. These might be simple one letter or one sentence affairs, or they might consist of multiple-step problems that ask a reader to perform a series of related operations, with the output from one operation providing a component of the next operation.

In terms of the studies that I have cited and the notions of active responding and instructional control, and adjunct aid must direct attention and guide learning by making use of the cue properties within a text, and the cue properties of the knowledge and response events that consequently emerge.

The question of what form a specific aid should take is one of how it might make use of the relational elements of connected discourse in order to overcome the deficiencies of stimulus control that accompany a particular instructional document.

A preliminary set of these functions, the first six of which were implicated in the studies that I reviewed, includes how they might arouse, direct, simplify, prompt, pace, sequence, maintain, amplify, and train learning activities.

Arousal. In terms of its arousal function, an adjunct aid might require some response from the learner, either overt or covert. A question is a useful device for arousing learning activities, and it is especially appropriate for text in which the response requirement is not an integral part of a small frame. It is clear, from the associative interpretation given to arousal in this paper, that sentences such as brief introductory comments, or statements that provide a superordinate context, might later induce responses to related information (see Ausubel, 1960; Gagné, 1969). But the function of requiring a specific response would be to insure that the learner carries out the activities that the response implies.

Direction. Secondly, an adjunct aid can direct attention to relevant portions of the text. An effective aid must clearly define the problem by selecting unambiguously related characteristics of the text. If such an aid must be transformed in some superfluous way, for instance, if words in a question are obscure paraphrases of the text (vague semantic variants, etc.), then it will be less efficient. Such difficulties might be desirable, however, if some specific contrast were intended. Data on the error rate for such aids would be important in planning their use. Such directions might take the form of conceptual relationships, e.g., "the concepts associated with gravity" in a physics text. They might be more precise, e.g., inferential questions that require processing selected sentences. Or they might be quite gross, e.g., "Study the first chapter of the text." The directive function of such aids mainly serves to orient the learner to some aspect of the text.

Simplification. A third function of adjunct aids might be to simplify reading activities. Simplification may involve (1) information load, and (2) processing activities. A simple factual question, for instance, allows the reader to eliminate much of the text and to arrive at a correct response directly. The likelihood

that the reader will get bogged down remembering irrelevant information is low. On the other hand, a series of relatively simple questions might compose a chain resulting in complex knowledge, such as the derivation of remote inferences or the elaboration of the precise stages in some complex biological process. Such aids might function to simplify text information directly, by providing linkages between sentences, in the form of topical labels, e.g., "Classify all the events according to the years in which they occurred."

Prompting. Fourth, an adjunct aid may function to prompt responses. For instance, underlining might serve to clarify and limit appropriate items in a text, such as phrases. A question of the form, "What can you deduce from points a and b?", not only selects a and b as relevant stimuli, but it also suggests that some new item of information might arise by appropriately combining them. In this sense, higher level skills can be prompted. A direction to "Recall the principle of osmosis." might prompt memory for an item necessary to comprehend a difficult passage. The prompting function of an adjunct aid might thus function in stimulus selection, recall, or to elicit some particular skill (see, Gagné, 1965).

Pacing. Fifth, the introduction of an adjunct statement or question might function to slow down the

pace of reading by requiring additional operations on the content, or perhaps by cueing the review of preceding portions of the text. The frequency of these aids would certainly be of concern in regard to desirable pacing requirements of the task. It would also be possible to increase reading rate by directing the reader not to be concerned with the ramifications of certain views, or the definition of unnecessary items.

Sequencing. Sixth, adjunct aids might also alter the sequence in which a reader (1) encounters items of content, or (2) the sequence in which he performs various cognitive activities. For instance, the reader might be given a list of the locations of paragraphs that contain summaries of important principles, with the direction to read them first, or the order of reading chapters in a book may be altered. On the other hand, the reader might be directed first to look up the definitions of a set of terms, rather than performing this task when these terms are being related to important concepts.

Maintenance. Adjunct aids might also function to maintain active responding by continually arousing problem solving activities. Apart from the pacing function of such aids, there are important uses for them in reinforcing separate stages of problem solution, in

conjunction with other complex directions. A number of studies relating to maintenance variables are reported in a recent review (Frase, 1970a).

Amplification. Adjunct aids might also add new content, and amplify the content that already exists. Because amplification involves the addition of new content, I have not dealt with amplification in this paper. Amplification might involve providing definitions for terms in a text, or cross-referencing topics with other reading materials. But amplification might also include the processes of imagery and hypostatization which we have heard about today. These processes are certainly important in the comprehension and retention of reading materials.

Training. A ninth use of adjunct aids, that seems particularly useful to me, is the training function that they might perform if they were properly developed. Given that they were effective in performing other functions, then the performance of those functions might gradually be taken over by the reader himself through the careful vanishing of these adjunct supports.

SUMMARY

There are many related papers on the use of adjunct questions, discovery learning and programmed

instruction that provide a broader context for the points that I have tried to bring to your attention in this paper. This broader context is the realm of educational technology in general. It has been my intention to show some connection between concepts taken from this technology and learning from written materials. In all of this, I suspect that the idea with the greatest pedogogical merit, is that we seldom do the kind of task analysis for text that would make it possible to adequately build adjunct aids. Such a practical task analysis includes first finding out what students learn from their texts without any outside management, and how this learning departs from what is desired.

But there is also a more subtle point that I had hoped these studies would convey. This point is that the activities that mediate learning can be manipulated by the introduction of verbal events that precede reading. These events modify processing activities which in turn determine the nature of the effective stimulus. By making explicit these prior events and their relationship to nominal text stimuli and learning outcomes, we may be able to arrive at a deeper conception of implicit learner-generated control processes.

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